SEXUAL DIMORPHISM IN THE CAUDAL SKELETON OF *CHEIRODON* (CHARACIDAE, TELEOSTEI).

by

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ABSTRACT. - There are fewer dorsal procurrent caudal rays than ventral ones in males and females of *Cheirodon pisciculus*, *C. galusdae*, *C. australe* and *Cheirodon* spp. (from Argentina and Chile). The shape of ventral procurrent caudal rays of *Cheirodon* is modified throughout ontogeny, and becomes a dimorphic sexual attribute separating adult females and males. The most anterior ventral procurrent caudal rays are formed by an elongate middle element bearing two lateral expanded bony processes in males, and they form a continuous series of bones, each one adjacent to the following one.

RESUME. - Il y a moins de rayons procurrents dorso-caudaux qu'il n'y a de rayons procurrents ventro-caudaux chez les mâles et femelles de *Cheirodon pisciculus*, *C. galusdae*, *C. australe* et *C.* spp. (de l'Argentine et du Chili). La forme des rayons procurrents ventro-caudaux se modifie au cours de l'ontogenèse et devient un caractère reflétant le dimorphisme sexuel chez les adultes. Les rayons procurrents ventro-caudaux les plus antérieurs sont formés par un élément médian allongé, portant chez les mâles deux processus latéraux osseux élargis; de plus, ils forment une série continue d'os, chacun de ces derniers étant adjacent au suivant.

Key words : Characidae, *Cheirodon*, Caudal skeleton, Ontogeny, Sexual dimorphism.

The genus *Cheirodon* (*sensu* Fink and Weitzman, 1974) occurs from Central America to southern South America. In southern South America, *Cheirodon* is represented by at least three Argentinean species (Ringuelet *et al.*, 1967), and ranges southward to the latitude of Buenos Aires (about 35° S). In Chile, *Cheirodon* is represented by four endemic and one introduced species, occuring from Vallenar (28°25'S latitude) to Puerto Montt (41° 30' S latitude) (Eigenmann, 1927; Arratia, 1981 : Fig. 8; Campos 1982). *Cheirodon pisciculus* Girard, the type-species, has the most northern (and discontinuous) distribution among the Chilean species.

The caudal skeleton of *Cheirodon* is known from the Argentinean *C. piaba*, *C. interruptus interruptus* (Miquelarena, 1982) and the Chilean *C. pisciculus* (Vandewalle, 1985). Numbers of caudal fin-rays and presence or absence of bony hooks in caudal rays of five Central American species were discussed by Fink and Weitzman (1974). The known caudal skeleton of the above mentioned species has the general pattern described for other characids (see for instance Weitzman, 1962; Miquelarena, 1982, 1984). One interesting feature of the caudal skeleton of the species of *Cheirodon* is the variable number of dorsal and ventral procurrent caudal rays; the number of dorsal and ventral procurrent caudal rays (serrae or interhemal spines of other authors) has been used as a character distinguishing southern South American species of *Cheirodon* (Eigenmann, 1927; Ringuelet *et al.*, 1967 ; Campos, 1982).

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Vandewalle (1985) published a note on the caudal skeleton of *Cheirodon pisciculus*. Although he considers its form to be basically characid, its procurrent caudal rays are distinctive : (1) each procurrent ray is formed by two medially separated halves, and (2) the procurrent rays are more numerous than expected from metamerization of the caudal region of the body. Figure 1 of Vandewalle (1985) depicts the caudal skeleton and most posterior anal fin-rays, supposedly of *C. pisciculus*, however the skeleton figured does not represent *Cheirodon pisciculus*, but it is that of *C. galusdae* or *C. australe*. According to Campos (1982) and the evidence presented below, *Cheirodon pisciculus* and *C. kiliani* have few procurrent rays in the ventral lobe of the caudal fin which occupy about half of the length of the caudal peduncle, whereas *C. galusdae* and *C. australe* have many procurrent caudal rays which occupy most of the length of the peduncle, as in Vandewalle's illustration (1985 : Fig. 1). The present paper describes and interprets the procurrent caudal rays of *C. pisciculus*, the type species of the genus, and of other southern South American species of *Cheirodon*.

MATERIAL AND METHODS

Specimens were sexed by microscopic examination of the gonads; the presence or absence of bony hooks in the pelvic, anal and caudal fins was checked.

The 125 cleared-and-stained specimens studied are catalogued at the Museum of Natural History, Lawrence, Kansas, USA (KU), and in the private collection of the author (PC); part of this collection was studied by Campos (1982) at IZUA (Instituto de Zoología, Universidad Austral, Chile).

Material examined :

Cheirodon pisciculus Girard : PC 177 (IZUA 2287), 4 females, 9 males; Rio Angostura, Maipo basin, Chile; collected by H. Diaz, August 15, 1975. PC 201, 7 females, 8 males ; Rio Angostura, Maipo basin ; G. Arratia, H. Diaz and A. Chang, January, 1975. PC 214, 8 females ; Rio Til-Til, Maipo basin; G. Arratia, February, 1975. PC 130173, 10 young specimens; Rio Las Hualtatas, Maipo basin; R. de Andrade and G. Arratia, January 1, 1973. KU 19391, 3 females, 1 male ; Rio Mapocho, Maipo basin; G. Arratia and H. Diaz, January 5, 1975.

Cheirodon galusdae Eigenmann : PC 200 (IZUA 2298), 34 females, 17 males; Rio Maule, Talca, Chile; G. Arratia, A. Morán and H. Diaz, January 28, 1975. KU 19390, 4 females, 1 male; Rio Maule, Talca ; G. Arratia *et al.*, January 14, 1975.

Cheirodon australe Eigenmann : PC 19276, 5 young specimens; Rio San Pedro, Los Lagos, Chile ; G. Arratia and H. Diaz ; February 19, 1976. KU 19388, 2 males, Rio Vergara, Angol, Chile ; H. Diaz and A. Chang, March 5, 1975.

Cheirodon sp. 1 : PC 191 (IZUA 2310), 2 specimens, El Vergel, Angol, Chile ; F. Camilo ; January 14, 1976.

Cheirodon sp. 2 : KU 19196, 5 males, El Carrizal, Mendoza, Argentina ; G. Arratia and A. Chang, March 19, 1976. KU 19198, 5 females, El Carrizal, Mendoza, Argentina ; G. Arratia and A. Chang, March 19, 1976.

The principal caudal fin-rays were counted as all branched rays plus one unbranched ray in each lobe, following Hubbs and Lagler (1947). In addition, I present here counts of the procurrent caudal rays, segmented, and branched-segmented rays of both dorsal and ventral lobes of the caudal fin. Numbers of rays of the dorsal lobe precede those of the ventral lobe. The procurrent caudal ray numbered as 1 is the most anterior one, the following rays are numbered consecutively.

RESULTS

The caudal skeleton of *Cheirodon pisciculus* (Fig. 1A), *C. galusdae*, *C. australe*, *Cheirodon* sp. 1 (from Chile) and *Cheirodon* sp. 2 (from Argentina) is similar to that of other characids in having a compound last vertebral centrum fused dorsally to the urostyle (uroneural), laterally to a moderately long pseudo-urostyle (absent in some characids) which may reach the base of hypural 5, and ventrally fused to hypural 2 and parhypural. A long separate uroneural, six hypurals and one to three epurals are present.

Most specimens have two epurals (Table I), but two females have only one epural, another two females have three epurals, and four males have only one epural in *C. pisciculus*. One male presents one epural in *C. galusdae* and *C. australe*. Thus, the variation in number of epurals is independent of sex.

The caudal fin-rays (Table I) are related to five to seven vertebrae (most often six) in *Cheirodon pisciculus* ; to seven or eight vertebrae in *C. galusdae* and *C. australe* ; and to eight or nine vertebrae in *Cheirodon* sp. 1 and 2 (nine the most frequent value). For total number of caudal fin-rays see Table I. The dorsal lobe of the caudal fin has fewer rays than the ventral lobe (Table I) in all species studied. Males have a little higher number (Table II) than females as also stated by Campos (1982). Bony hooks or serrae are absent on the caudal rays of all specimens studied with the exception of the last dorsal procurrent caudal ray of males and of large females (see below). The number of principal caudal rays is usually 9-10 (dorsal and ventral lobe respectively) (Tables I, II) in males and females but one female has 10-11 and one male 9-9 in *C. pisciculus* ; and one male has 9-9 in *C. galusdae*.

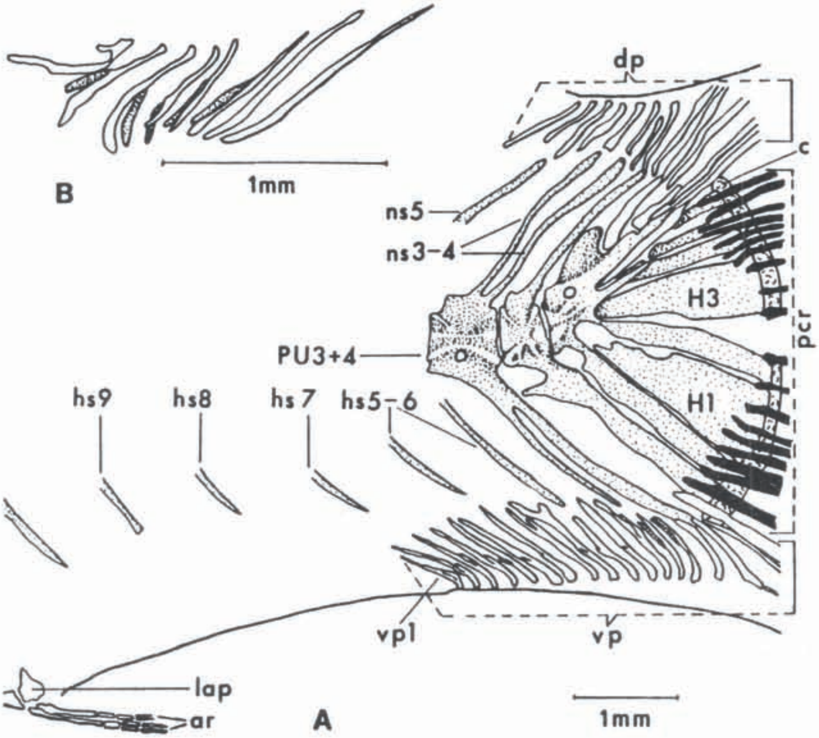

Fig. 1 : *Cheirodon pisciculus.* A: Lateral view of the caudal skeleton of a sexually mature female of 38.4 mm in standard length SL (PC 177 [IZUA 2287]). B: Lateral view of the anterior dorsal procurrent caudal rays 1-8 of a sexually mature male of 37 mm SL (PC 177 [IZUA 2287]).
ar: last anal ray; c: cartilage; dp: dorsal procurrent caudal rays; H1,3: hypural 1; HS5-9: haemal spine of preural centra 5-9; lap: last anal pterygiophore; ns3-5: neural spine of preural centra 3-5; pcr: principal caudal rays; PU3+4: preural centra 3+4; vp: ventral procurrent caudal rays.

Table I : Comparison of some features of the caudal skeleton of species of *Cheirodon* (occasional value in bracket).

	C. pisciculus	*C. galusdae*	*C. australe*	*C. sp. 2*
vertebrae	5-6 (7)	(7) 8	8	8-9
epurals	(1) 2 (3)	(1) 2	(1) 2	2 (3)
dorsal lobe rays	21-25	18-24	22-23	20-28
ventral lobe rays	24-31	31-37	33-37	33-37
dorsal procurrent rays	11-16	7-14	12-13	9-13
dorsal principal rays	(9) 10	(9) 10	10	(9) 10
ventral principal rays	9 (10)	9	9	9
ventral procurrent rays	15-21	21-28	23-28	24-28
total number of rays	45-56 (60)	(49) 51-59	56-60	54-60

Cheirodon pisciculus

Young specimens (12.5 to 21.2 mm standard length): Males and females of *C. pisciculus* do not differ in the structure of the caudal fin in early ontogenetic stages. They have no bony hooks on pelvic, anal and caudal fins.

The hypurals 1--2 are totally fused in 50 % of the young specimens, partially fused in 10 % and separated in 40 % of the young. Preural vertebrae 2--3 are fused in 20 % of the specimens. The two uppermost dorsal principal caudal rays are connected with hypurals 5--6 or hypural 6 and the uroneural. The two lowest ventral principal caudal rays are connected to the parhypural and the haemal spine of preural centrum 2. Each thin small dorsal or ventral procurrent caudal ray is formed by two halves medially separated (specimen 14.7 mm standard length). All dorsal procurrent caudal rays are separated medially, whereas the most anterior ventral procurrent caudal rays are already medially fused in one specimen of 14.8 mm standard length. In another specimen of 14.8 mm standard length, the most anterior dorsal procurrent rays are medially fused whereas the six most anterior ventral procurrent caudal rays are separated; a few posterior ventral procurrent caudal rays begin to fuse their ventral tips. In other specimen the procurrent rays have begun to fuse at their ventral tips. The medial fusion of the halves of the procurrent caudal rays generally progresses from the most anterior ones caudally; the most posterior dorsal and ventral procurrent caudal rays (3 or 4 rays) remain separated in every specimen examined here.

Dorsal and ventral procurrent rays are narrow, slender bones medially separated in young specimens. Both halves of most dorsal procurrent rays fuse at their dorsal tips and form a simple forked-shaped element (in males and females). Both halves of most ventral procurrent caudal rays fuse to each other and form an elongate broad bone in females and males. The middle elongated bone forms lateral projections which are sharp small processes in early ontogeny and expand antero-posteriorly through ontogeny, in males.

Adult specimens: Fusion of hypurals 1--2 was observed in only one large specimen. Fusion of preural centra 2--3 (38 %) and between other preural centra was observed in other specimens. The number of dorsal and simple (not segmented, not branched) rays is lower than in young specimens (Table II), whereas the number of dorsal and ventral segmented (not branched) rays is higher than in young specimens (Table II).

Table II : Number and distribution of caudal rays in young, females and males of *Cheirodon pisciculus* (average in bracket).

	young	females	males
n	10	16	18
dorsal simple rays	10 (12) 14	9 (10) 11	8 (10.1) 13
dorsal segmented rays	2 (2.4) 3	3 (3.5) 5	2 (3.6) 6
dorsal branched-segmented rays	9	9	8 (8.9) 9
ventral branched-segmented rays	8	8 (8.2) 10	8 (8.1) 9
ventral segmented rays	2 (2.8) 3	3 (3.8) 5	2 (4.2) 5
ventral simple rays	15 (17.7) 19	14 (16) 17	13 (15.7) 18
dorsal procurrent rays	11 (13) 15	12 (12.6) 15	11 (12.5) 15
dorsal principal rays	10	10	9 (9.9) 10
ventral principal rays	9	9 (9.2) 11	9 (9.1) 10
ventral procurrent rays	16 (18.7) 20	17 (18.5) 19	16 (18.5) 22
total number of rays	50 (51.8) 55	48 (49.9) 52	48 (49.9) 52

The two uppermost principal caudal rays may be connected with hypurals 5--6, or hypural 6 and uroneural, whereas the two lowermost principal caudal rays are commonly connected to the parhypural and the haemal spine of preural centrum 2.

There are fewer dorsal procurrent caudal rays than ventral ones in males and females (Tables I-III). Females and males have similar number of dorsal procurrent caudal rays (Table III). Shape and morphology of the dorsal procurrent caudal rays are highly variable from specimen to specimen in both sexes (Fig. 1A-B). Usually the procurrent caudal ray 1 is simple; it is followed by procurrent caudal rays which may be simple (by fusion of both halves or loss of one half), or forked.

The number of ventral procurrent caudal rays varies a little more in males than in females (Table IV), but the average is similar in both sexes (Table II). The main difference between adult males and females is in morphology of the ventral procurrent caudal rays.

Females: The ventral procurrent caudal rays of females are elongated (Figs. 1A, 2A-B). The anteriormost ventral procurrent caudal ray is simple (Fig. 2A) and the following ten to twelve procurrent caudal rays are also simple, formed by the fusion of both halves in early ontogeny (Figs. 1, 2B); each ventral procurrent caudal ray may have small lateral outgrowths which do not develop during ontogeny. The most posterior ventral procurrent caudal rays may be forked but the last two to four of them are formed by two separate halves. Each procurrent caudal ray is separated from the following one by a short space (Figs. 1A, 2A-B).

Males: The most anterior ventral procurrent caudal rays of males are formed by a middle elongated bone which produces lateral expanded bony processes (Fig. 3A-C). The lateral expanded processes divide each procurrent caudal ray into two regions, a laminar thin dorsal region and a laminar thick ventral region; the ventral region has a lanceolate or leaf-like shape. The posterior ventral procurrent caudal

Table III : Distribution of the number of dorsal procurrent caudal rays in females and males in species of *Cheirodon*.

	7	8	9	10	11	12	13	14	15
C. pisciculus (female)	-	-	-	-	-	7	4	-	1
C. pisciculus (male)	-	-	-	-	3	5	2	1	2
C. galusdae (female)	-	1	2	6	13	7	4	1	-
C. galusdae (male)	1	-	-	5	6	3	2	-	-
C. australe (female)	-	-	-	-	-	3	-	-	-
C. australe (male)	-	-	-	-	-	-	3	-	-
C. sp. 2 (female)	-	-	-	-	2	2	1	-	-
C. sp. 2 (male)	-	-	2	1	2	-	-	-	-

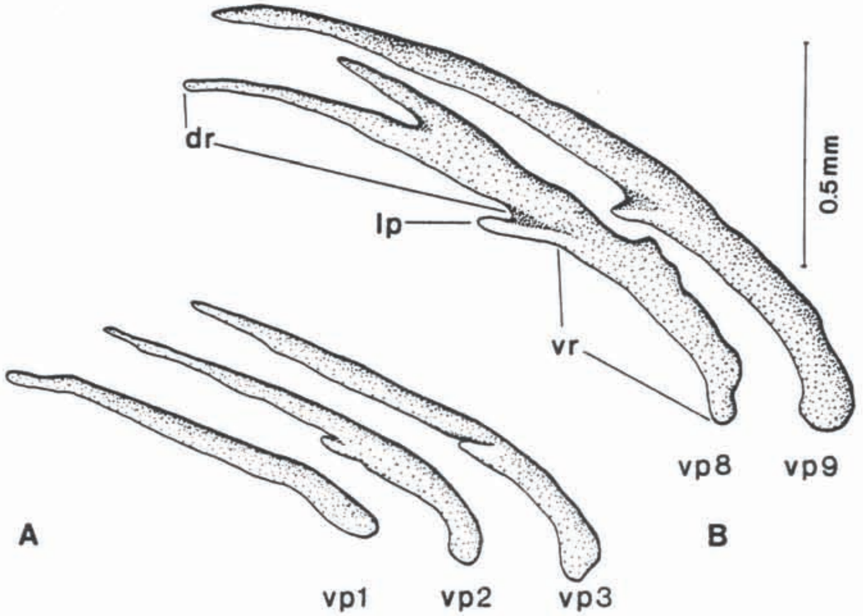

Fig. 2 : ***Cheirodon pisciculus***. Lateral view of the dorsal procurrent caudal rays 1-3 (A) and 8-9 (B) in a sexually mature female of 52 mm SL (PC 214).
dr: dorsal region of a procurrent caudal ray; lp: lateral process of a procurrent caudal ray; pvl-9: ventral procurrent caudal rays 1-9; vr: ventral region of a ventral procurrent caudal ray.

rays have shorter lateral processes (Fig. 4A), and these are absent in the last procurrent caudal rays. The procurrent caudal rays of adult males form a continuous series, and each procurrent caudal ray is firmly connected with the following one.

The last dorsal procurrent caudal ray (preceding the first dorsal principal ray) presents commonly small serrae (bilateral or not) in its first segment in males and

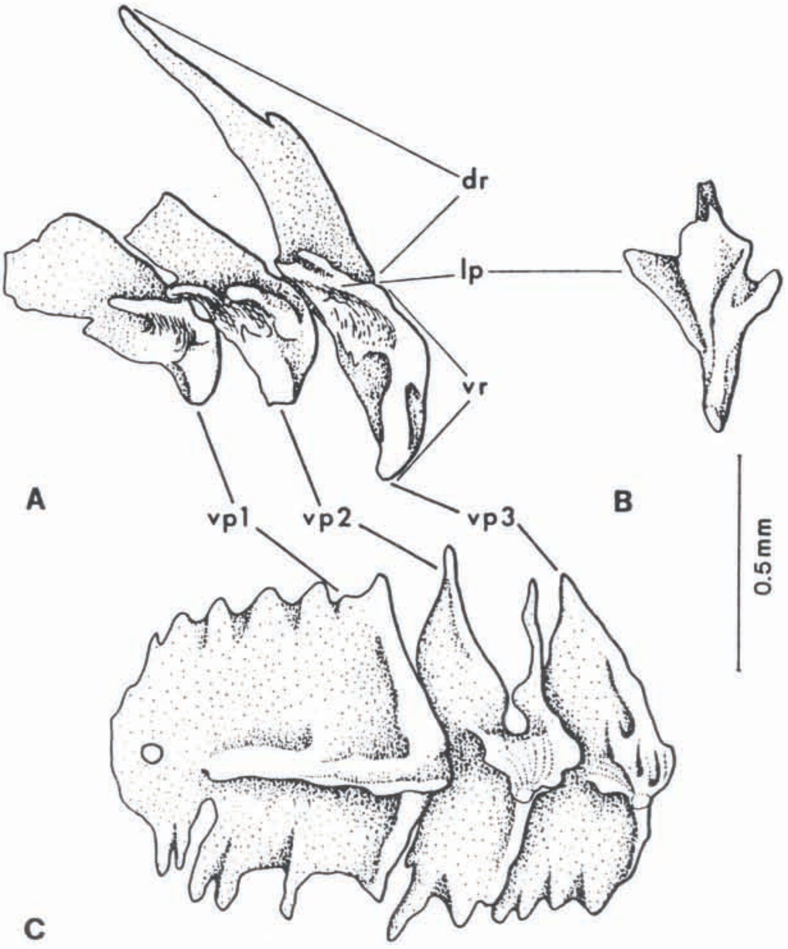

Fig. 3 : *Cheirodon pisciculus*. First procurrent caudal rays of sexually mature males. A: ventral procurrent caudal rays 1-3, in lateral view of a specimen of 40 mm SL (PC 177 [IZUA 2287]). B: ventral procurrent caudal ray 2, in posterior view, of a specimen of 40 mm SL (PC 177 [IZUA 2287]). C: ventral procurrent caudal rays 1-3, in ventral view of a specimen of 38 mm SL (PC 177 [IZUA 2287]).
lp: lateral processes of a procurrent caudal ray; dr: dorsal region of a ventral procurrent caudal ray; pvl-8: ventral procurrent caudal rays 1-8; vr: ventral region of a ventral procurrent caudal ray.

in large females. Serrations may be found in the following segments of the ray and, in one specimen, also in the last segment.

The number of vertebrae supporting the bones of the caudal skeleton is higher in the other species studied than in *C. pisciculus* (Table I). Fusion of hypurals 1--2 was neither observed in any specimen of *C. galusdae*, *C. australe*, and *Cheirodon* spp., nor in young or larger specimens. Preural centra 2--3 are fused in some specimens of *C. galusdae*. The uppermost principal caudal rays may be connected to hypural 6 and the uroneural, or to hypurals 5 and 6, whereas the

Table IV : Distribution of the number of ventral procurrent caudal rays in females and males in species of *Cheirodon*.

	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
C. pisciculus (female)	-	-	-	2	4	5	-	1	-	-	-	-	-	-	-
C. pisciculus (male)	-	-	3	-	3	4	1	1	1	-	-	-	-	-	-
C. galusdae (female)	-	-	-	-	-	-	-	3	3	5	8	8	4	1	1
C. galusdae (male)	-	-	-	-	-	-	-	-	4	5	3	4	-	-	-
C. australe (female)	-	-	-	-	-	-	-	-	-	1	-	1	1	-	-
C. australe (male)	-	-	-	-	-	-	-	-	-	-	-	2	-	-	1
C. sp. 2 (female)	-	-	-	-	-	-	-	-	-	-	-	1	2	2	-
C. sp. 2 (male)	-	-	-	-	-	-	-	-	1	-	-	4	-	-	-

lowermost principal caudal rays are usually connected to the parhypural in *C. galusdae*, *C. australe* and *Cheirodon* spp.

Dorsal and ventral procurrent caudal rays similar to those above described in *C. pisciculus* (Figs 1A-B, 2, 3A-C, 4A) were found in the other species of *Cheirodon* of Chile. The basal region of each ventral procurrent caudal ray may be simple, bifurcated, or serrated in *C. galusdae* (Figs 4B, 5A) and *C. australe* (Fig. 4C). The lateral processes are usually very expanded and developed, from the first ventral procurrent caudal ray caudally ; they have irregularly serrated margins in *C. galusdae* (Figs 4B, 5C), whereas they often are irregularly bifid in *C. australe* (Fig. 4C). Modified dorsal and ventral procurrent caudal rays which have large expanded lateral processes are found in sexually mature males of *Cheirodon* sp. 1 (of Chile).

The series of ventral procurrent caudal rays reach close to the last anal pterygiophore in *C. galusdae* (Fig. 4B) and in *C. australe* (Fig. 4C), whereas the first procurrent ray is remote from the last anal pterygiophore in *C. pisciculus* (Fig. 1A).

The number of the procurrent caudal rays vary between the species studied (see Tables I, III, IV); nevertheless, 1) the ventral lobe always has more rays than the dorsal one, 2) the ventral procurrent caudal rays are always more numerous than the dorsal ones (compare Tables III and IV). The total number of rays in dorsal and ventral lobes, or of dorsal and ventral procurrent caudal rays, does not differ significantly between males and females in any species; nevertheless, these features are helpful in separating different species (Table IV).

DISCUSSION

Although the pattern of the caudal fin skeleton of the species of *Cheirodon* studied here is similar, there is a great variability in the shape and size of the neural arch and spine, of the compound centrum and of the epurals. This variability is present in specimens of both sexes. One aspect to be mentioned is the fusion between hypurals 1--2 in young specimens of *C. pisciculus*, whereas they are unfused in adults (with exception of one specimen). This fusion was only found in young *C. pisciculus* and it is an uncommon feature; usually it is accepted that two bones may become fused but, in this species, one compound bone in early ontogeny becomes separated into two bones (hypurals 1--2) in adults.

The presence of two epurals is commonly accepted for members of the family Characidae (Weitzman, 1962 ; Miquelarena, 1982). The Chilean species of *Cheirodon* have usually two epurals, but some males and females may have three epurals, or only one. Such a variation in the number of epurals was found in *C. pisciculus*, *C. galusdae* and *C. australe*. In *C. pisciculus*, the presence of only one epural is more frequent in males (22.2 %) than in females (12.5 %).

Compared with adults, young specimens commonly have more simple unsegmented rays and few segmented (not branched) rays in dorsal and ventral caudal lobes. Segmented (but not branched) rays increase in number because the simple rays become segmented during growth (see Table I). A similar situation has been described for another ostariophysan, the catfish *Nematogenys* (Arratia, 1982 : 54, Table I).

Most of the specimens have 9-10 principal caudal fin-rays. Only a few specimens of the species studied differ in this count (one with 10-11; one with 10-10 ; and four with 9-9). The variation of this feature occurs in both sexes.

The dorsal lobe of the caudal fin has fewer procurrent caudal rays than the ventral lobe in males and females (compare Tables III and IV) in the southern South American species of *Cheirodon* studied here. One exception is *Cheirodon interruptus interruptus* from Lago Peñuelas and Rio Aconcagua in Valparaiso, Chile (Campos, 1982). Campos (1982 : 154) assumed that this species has been introduced in Chile, probably from Buenos Aires, Argentina (this species inhabits also Rio Uruguay, Rio

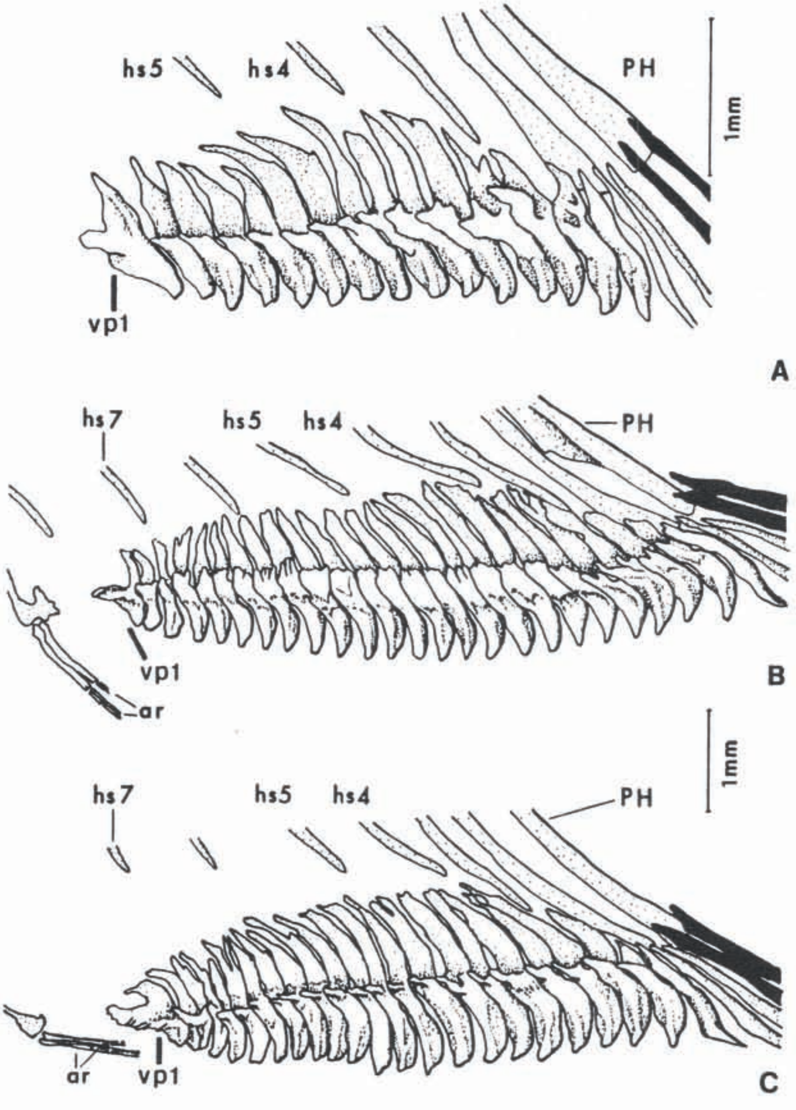

Fig. 4 : Lateral view of the ventral procurrent caudal rays in sexually mature males. A: *Cheirodon pisciculus*, specimen of 37 mm SL (PC 177 [IZUA 2287]); B: *Cheirodon galusdae*, specimen of 37 mm SL (KU 19390); C: *Cheirodon australe*, specimen of 34 mm SL (KU 19388). (Lowermost principal rays in black.)
ar: last anal ray; hs4-7: haemal spine of preural centra 4-7; PH: parhypural; vp1: ventral procurent caudal ray 1.

Paraná and Tala in Salta, Argentina, according to Ringuelet *et al.*, 1967 : 91). *C. interruptus interruptus* from Chile has... "caudal sin rayos prorecurrentes dorsales. En el lóbulo superior hay 3 rayos no ramificados y 8 a 9 ramificados, predominando 9" (= caudal fin without dorsal procurrent rays. There are 3 unbranched rays and 8 to 9 branched rays in the upper lobe, commonly 9) (Campos, 1982 : 153). My interpretation of this sentence is that the dorsal lobe has two procurrent caudal rays

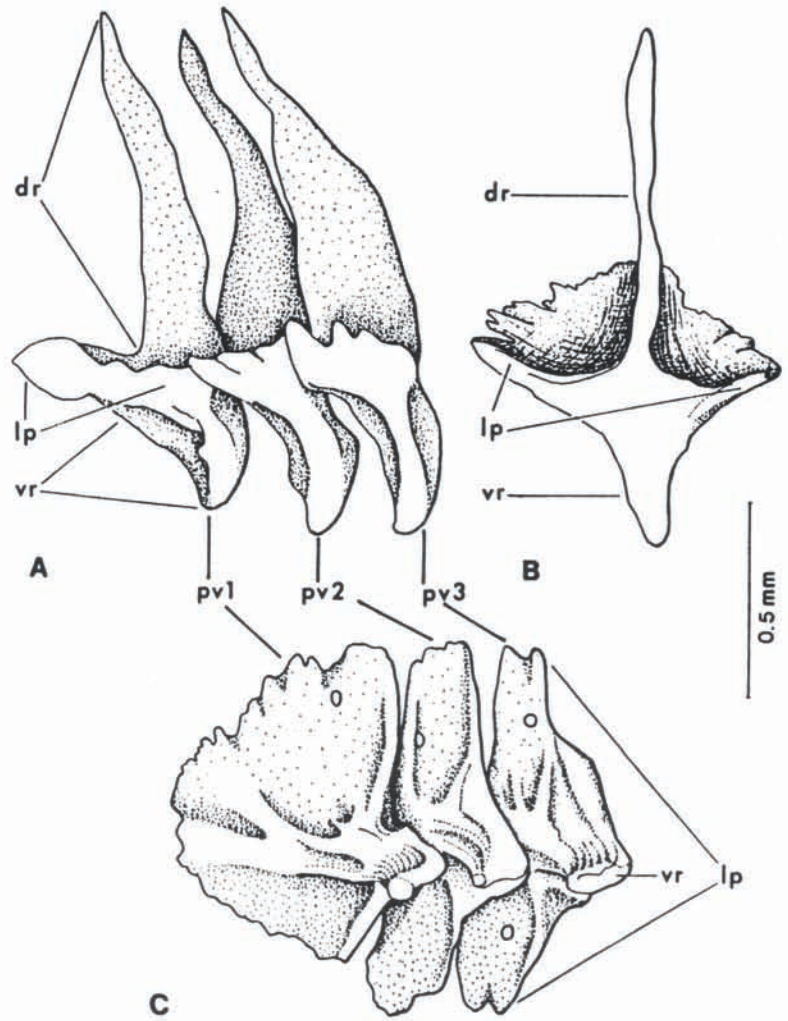

Fig. 5 : *Cheirodon galusdae.* First ventral procurrent caudal rays in sexually mature males of about 40 mm SL (PC 200). A: ventral procurrent caudal rays 1-3, lateral view. B: ventral procurrent caudal ray 1, posterior view. C: ventral procurrent caudal rays 1-3, ventral view.
dr: dorsal region of a ventral procurrent ray; lp: lateral process of a procurrent caudal ray; vr: ventral region of a ventral procurrent caudal ray.

and nine or ten principal caudal rays, commonly ten. In contrast, *C. interruptus interruptus* from province of Buenos Aires in Argentina, has eleven dorsal procurrent caudal rays (Miquelarena, 1984 : 298, Fig. 33). Therefore, the low number of dorsal procurrent caudal rays of the so-called *Cheirodon interruptus interruptus* from Chile appears to be unique at least within the known species of the southern South American *Cheirodon*.

The dorsal procurrent caudal rays change their size and shape during ontogeny, in both sexes of *Cheirodon pisciculus*, *C. galusdae*, *C. australe*, and *Cheirodon* sp. 2 (from Argentina). Nevertheless, adult males and females of the above mentioned species are similar in this feature. In contrast, modified dorsal procurrent caudal rays with long and well developed lateral bony processes are present only in males of *Cheirodon* sp. 1 (from Chile). This feature seems to be unique among species of *Cheirodon*.

The ventral procurrent caudal rays change their size and shape during ontogeny; no significant difference is present in young males and females, nevertheless this feature evolves differently in both sexes and it becomes a sexual attribute separating adult males and females. The fusion of both halves of each procurrent caudal ray and the development of lateral bony processes of each procurrent caudal ray is a feature of large males; large females may form small lateral bony processes in each procurrent caudal ray but they do not have a continuous series of contiguous ventral procurrent caudal rays as do males. This is noteworthy because this sexual dimorphism of the procurrent caudal rays (dorsal or ventral) is not described in other species of *Cheirodon*. Descriptions of osseous elements with sexual dimorphism in the caudal skeletons are not abundant in the literature about Teleostei. See for instance : Fink and Weitzman (1974 : 9, 14), Weitzman and Fink (1985 : 77, 87, 89, 114, 115, Figs 11, 12, 16, 17, 19, 46, 47) and Vari (1982 : 5, Fig. 5) for bony hooks and modification of the shape of some principal caudal fin-rays of males of some characids; Weitzman and Fink (1985 : 13, 81, Figs 8, 9, 10, 11, 13, 14) for fusion of parhypural to hypural 1 in sexually mature xenurobryconin males; Vari (1982 : 4, 5, Fig. 1-4) for hypural modification and modification of neural and haemal spines of the preural centra 3--2 of males of the characoid *Curimatopsis*.

Table IV illustrates that the number of ventral procurrent caudal rays is not a sexual dimorphic attribute of males or females in the species studied. Nevertheless it is a significant feature separating *Cheirodon pisciculus*, the type-species, from all the other studied species of the genus.

Vandewalle (1985) noted the loss of correspondence in the number of procurrent caudal rays and the metamerization of the body. There is not a one-to-one correspondence between the haemal spines of the last preural centra and the ventral procurrent caudal rays (see Figs 1A, 4A-C) in the characids studied. For example, seventeen or eighteen ventral procurrent caudal rays are related to five or six haemal spines (including the parhypural) in *C. pisciculus*, or twenty-seven ventral procurrent caudal rays may be related to eight haemal spines in *C. galusdae*. This feature that Vandewalle (1985) found peculiar to *C. pisciculus* is found in fossil (Nybelin, 1963 : Figs 6, 8; Patterson, 1970 : text-figs 27, 45, 48) and recent teleosts (Weitzman, 1962 : Fig. 15; Arratia, 1982 : Figs 6A, 7A; Miquelarena, 1982 : Figs 13A, 34, 35), and also in *Lepisosteus* and amiiforms, as first noted by Nybelin (1977).

The series of enlarged modified procurrent caudal rays present in males of *Cheirodon*, probably means some difference in the swimming of large males and females, but that is an assumption to be checked.

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